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G01P 15/12

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(54) Semi-conductor acceleration sensor

(57) A semi-conductor acceleration sensor comprises a thick weight 901 made of a semi-conductor, a thick support member 906 surrounding the weight, four thick protrusions 901 A-D connected to the weight 901, and four thin beams 902, 903, 904, 905 which connect the weight 901 with the support member 906. As shown each beam carries a respective pair of strain gauges (e.g. 902A, 902B) at the junctions with the support and the respective protrusion. The gauges are connected in a bridge circuit to cancel the sensor output for accelerations in directions other than perpendicular to the plane of the support 906.

FIG. 18A

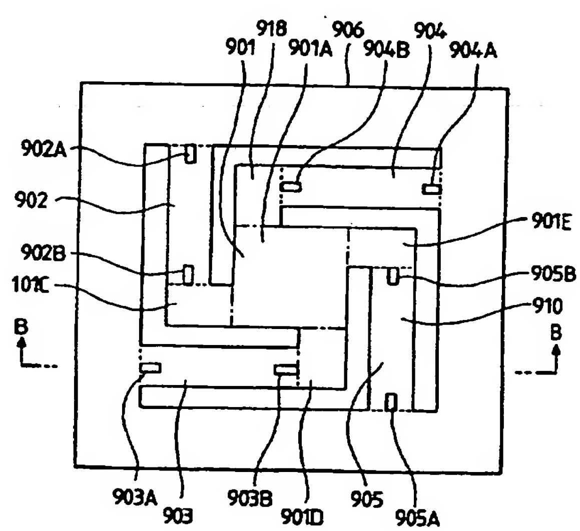

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FIG. 1A

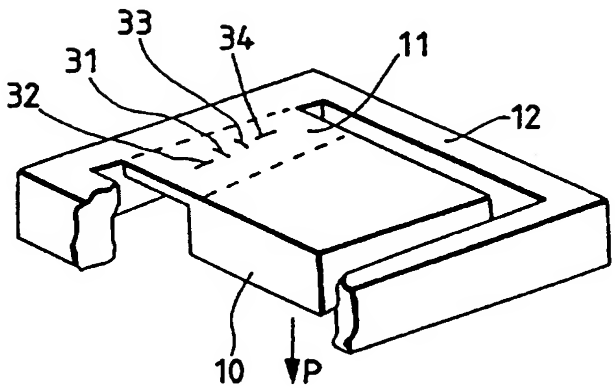


FIG. 1B

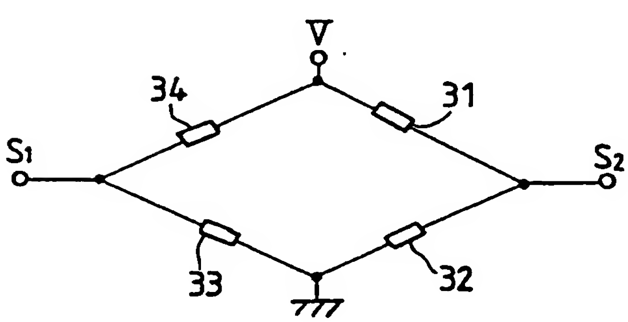


FIG. 2

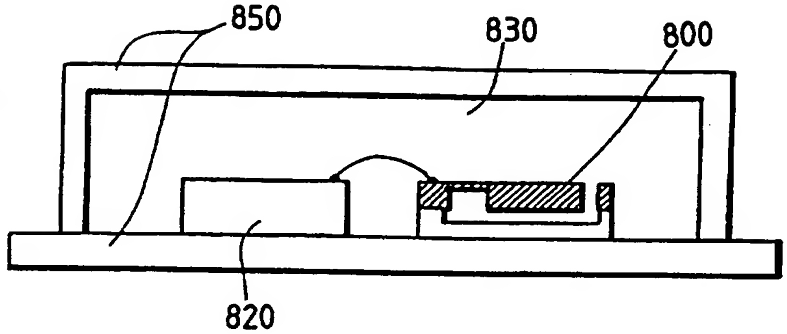


FIG. 3

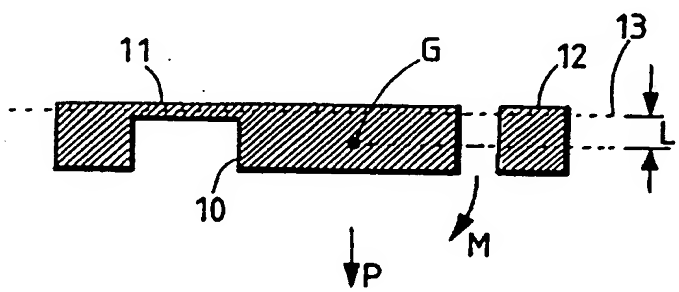


FIG. 4

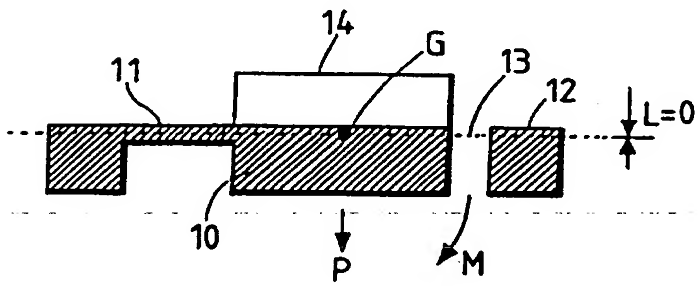


FIG. 5

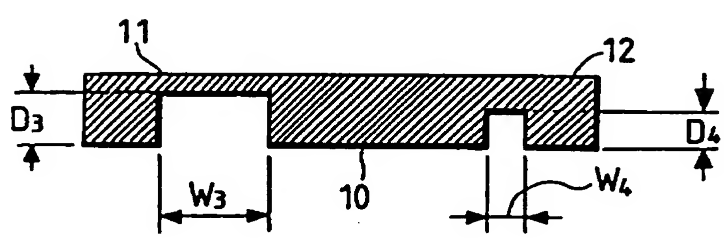


FIG. 6

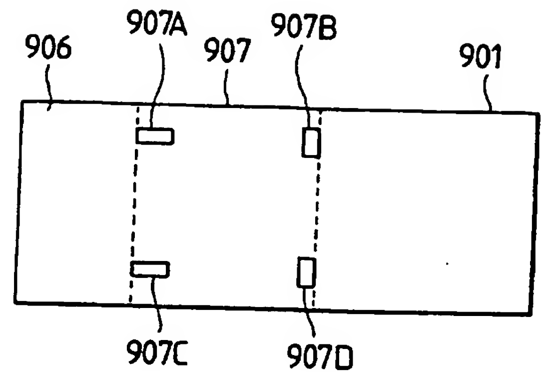


FIG. 7

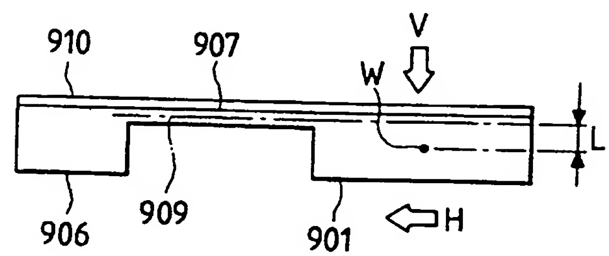


FIG. 12

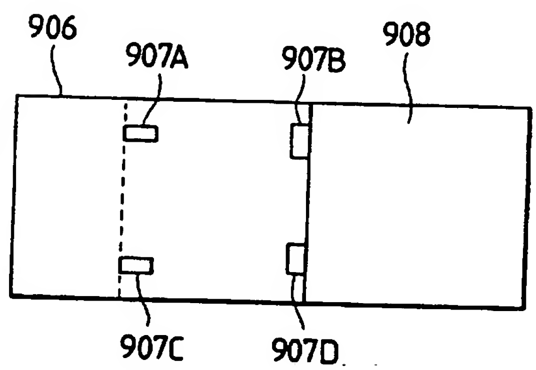


FIG. 13

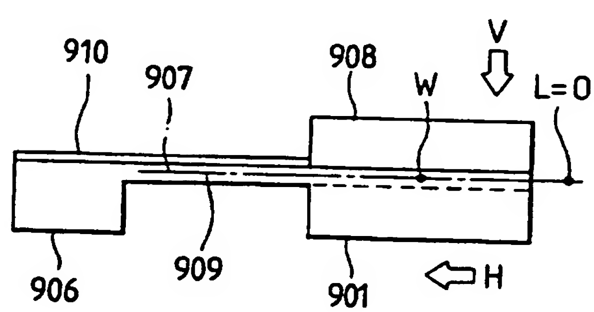


FIG. 8

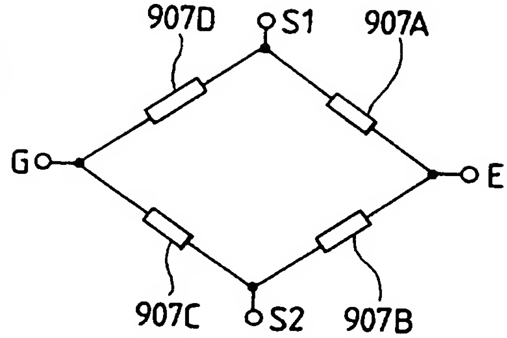


FIG. 9

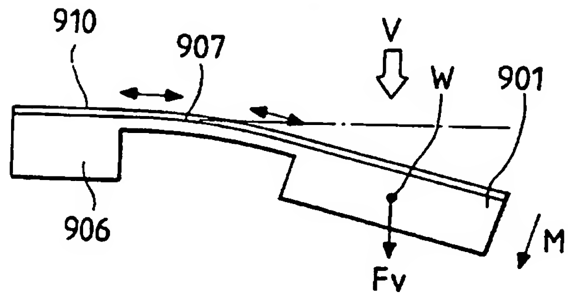


FIG. 10

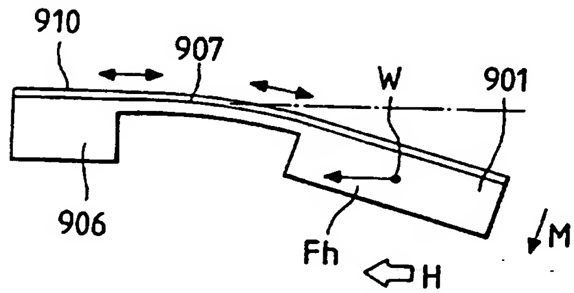


FIG. 11

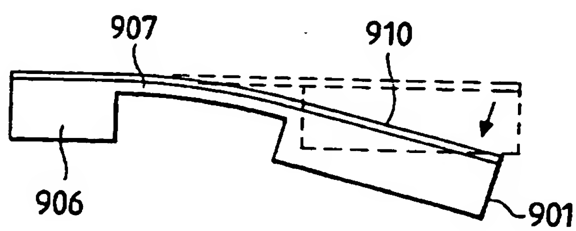


FIG. 14A

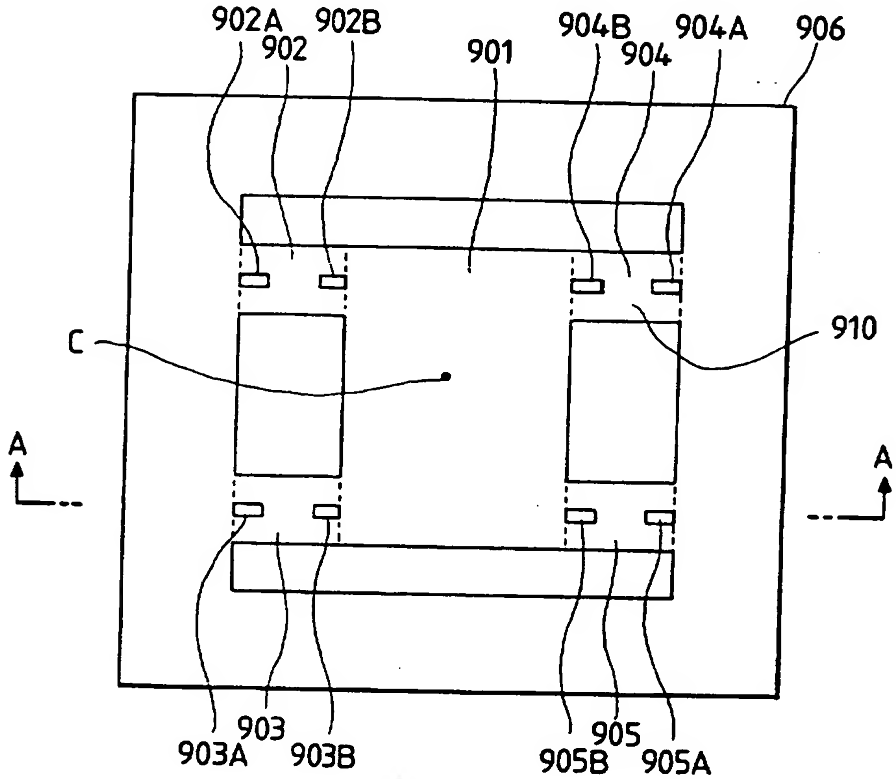


FIG. 14B

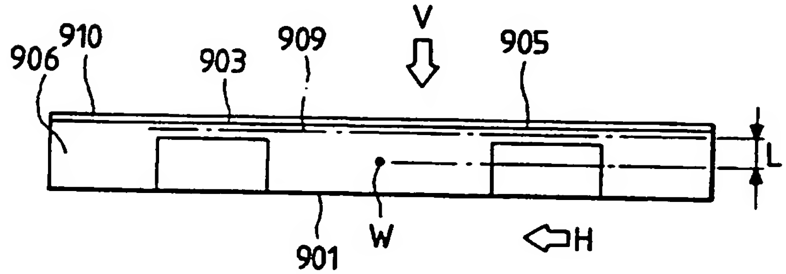


FIG. 15

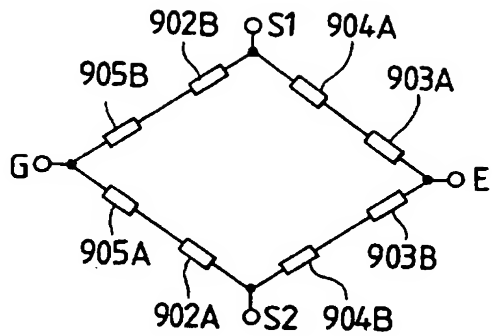


FIG. 16

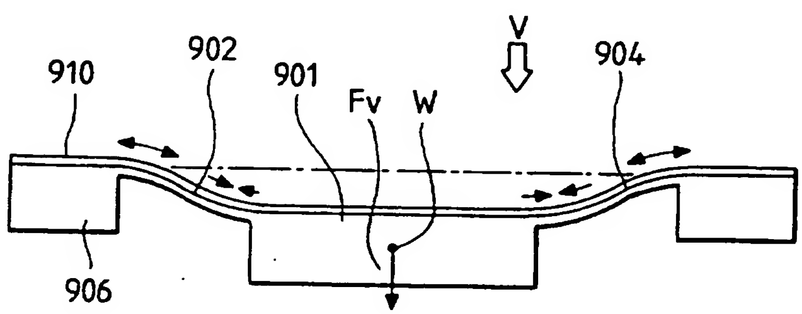


FIG. 17

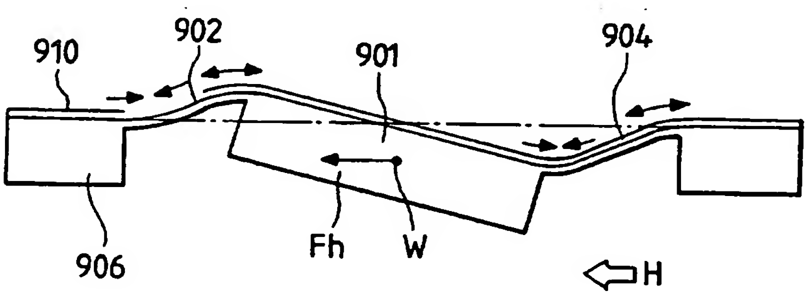


FIG. 18A

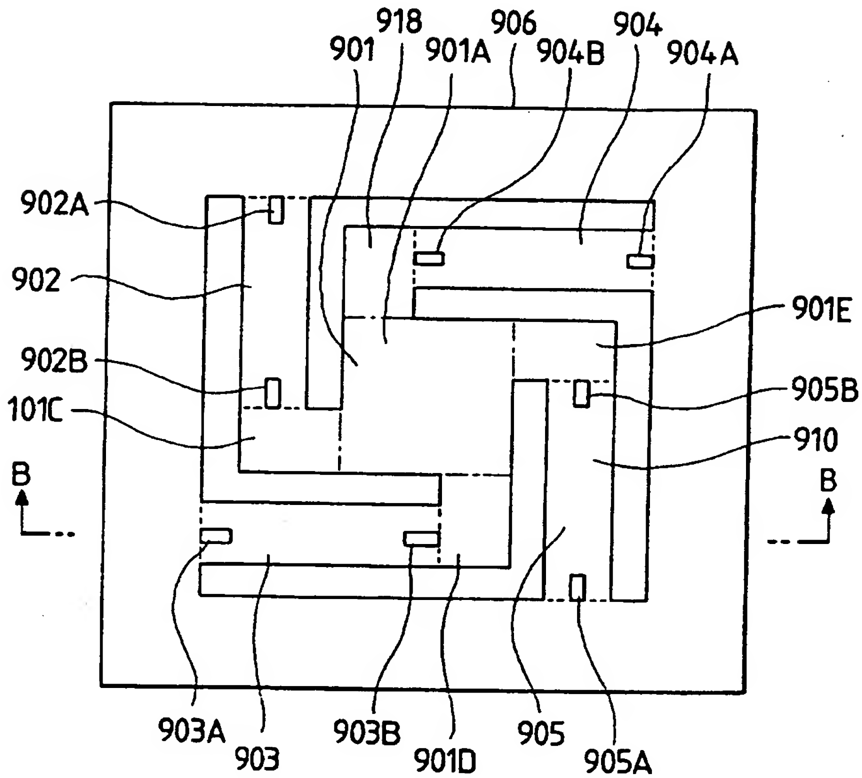
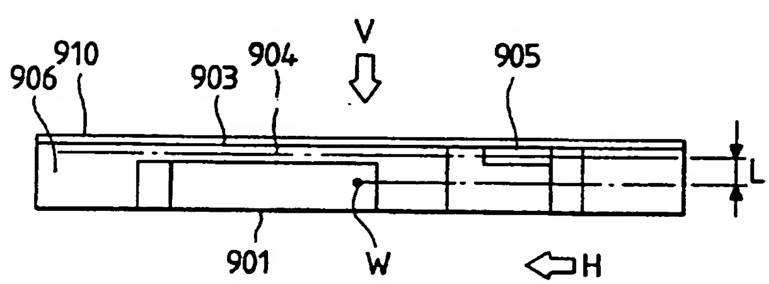


FIG. 18B



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SEMI-CONDUCTOR ACCELERATION SENSOR

This invention relates to an acceleration micro-sensor which is made of a semi-conductor.

A conventional semi-conductor acceleration sensor is shown in Figures 1A and 1B. Figure 1A is a perspective view and Figure 1B is a circuit diagram. In Figure 1A, the semi-conductor acceleration sensor comprises a quadrangular prism-like thick weight 10 made of a semi-conductor and having a thickness of, for example, 400 microns, a thick support member 12 which is separated by a predetermined gap from the weight 10 and formed so as to surround it, and a thin beam 11 which connects one side face of the weight 10 with that of the support member 12 facing the one side face and which has a thickness of, for example, 10 to 40 microns. Strain gauges 31, 32, 33 and 34 are formed on the upper face of the beam 11. The strain gauges 31 and 33 are formed in the side of connecting it with the weight 10 and in the longitudinal direction of the beam 11, and the strain gauges 32 and 34 are formed in the width direction of the beam 11. These strain gauges 31 and 34 are electrically connected as shown in Figure 1B to constitute a Wheatstone bridge in which the strain gauges 31 and 33 are opposite to each other and the strain gauges 32 and 34 are opposite to each other. In Figure 1B, V designates a power supply terminal, and S_1 and S_2 designate signal output terminals.

When acceleration in the vertical direction (which is the direction of detecting acceleration) is applied to the weight 10, the weight 10 is subjected to a force in the vertical direction and the beam 11 deflects in the direction indicated by arrow P. At this time, a tensile stress acts on

the upper face of the beam 11, so that the resistance of each of the strain gauges 31 and 33 formed in the longitudinal direction of the beam 11 increases, and, in contrast, the resistance of each of the strain gauges 32 and 34 formed in the width direction of the beam 11 does not change. This causes a detection signal the level of which is proportional to the magnitude of the acceleration, to be output from the signal output terminals S_1 and S_2 of the Wheatstone bridge.

Because of the configuration where the weight 10 is supported at only one end, the semiconductor acceleration sensor has an impaired impact strength. As shown in Figure 2, therefore, such a semi-conductor acceleration sensor is usually accommodated in a hermetically sealed container 850 which contains a damping liquid 830. In Figure 2, 800 designates the semi-conductor acceleration sensor and 820 designates an amplifier for a detection signal.

In the semi-conductor acceleration sensor mentioned above, as shown in Figure 3, the deflection centre line 13 of the beam 11 is separated by a distance L from the centre of gravity G of the weight 10. When acceleration in the transverse direction (which is the direction of not detecting acceleration) is applied to the weight 10, therefore, a moment indicated by arrow M is generated by this acceleration and the distance L to be applied to the weight 10 so that the weight 10 is subjected to a force in the vertical direction in the same manner as the case where acceleration in the vertical direction is applied, thereby deflecting the beam 11 in the direction indicated by arrow P. This deflection causes the Wheatstone bridge to output a signal, and this signal output functions as an interference output to impair the detection accuracy.

As a countermeasure to this problem, a configuration may be proposed in which, as shown in Figure 4, an additional weight 14 made of glass or the like is jointed to the upper face of the weight 10 so that the centre of gravity G of the weight consisting of the weight 10 and the additional weight 14 exists on the deflection centre line 13 of the beam 11, thereby reducing the distance L therebetween to zero. However, this improved configuration has a problem in that an extra process step of joining the additional weight is required and the production cost is increased.

In the production of a semi-conductor acceleration sensor such as that shown in Figure 1 or 4, the weight 10, the support member 12 and the beam 11 are formed by engraving both the upper and lower faces of a semi-conductor substrate using working means such as a plasma etching apparatus. In such a plasma etching process, because of its working characteristics, the etching proceeds at a high rate when the working width is large and proceeds at a low rate when the working width is small. In the case that different working widths exist in a semi-conductor substrate under the working process as indicated by W_3 and W_4 in Figure 5 therefore, different engrave depths are obtained as indicated by D_3 and D_4. This raises a problem in that the accuracy of the engrave process is lowered, thereby reducing the production yield.

In order to improve the impact resistance, the above-mentioned semi-conductor acceleration sensors are usually accommodated in a hermetically sealed container which contains a damping liquid. The existence of the damping liquid causes the detection sensitivity to be reduced, and therefore it is required to estimate the reduction rate and to adjust the sensitivity before introducing the damping liquid into the container. Since the viscosity and compressibility of the damping liquid

change depending on the pressure and temperature, however, sensitivities vary to arise a further problem in that the production yield is impaired.

Furthermore, Figures 6 and 7 illustrate another conventional semi-conductor acceleration sensor by way of example: Figure 6 is a top view and Figure 7 a side view. As shown in Figures 6 and 7, the semi-conductor acceleration sensor comprises a thick-walled square weight 901 which is, for example, 400 μ thick, a thick-walled square support 906 set a predetermined space apart from one side of the weight, and a thin-walled beam 907 which is, for example, 20 ~ 40 μ thick, the beam coupling the one side of the weight 901 and an opposed side of the support 906. Strain gauges 907A, 907B, 907C, 907D are formed in the beam 907. The strain gauges 907A, 907C among them are formed in the top surface of the junction between the beam 907 and the support 906 in the lengthwise direction of the beam 907, whereas the strain gauges 907B, 907D are formed in the top surface of the junction between the beam 907 and the weight 901 in the crosswise direction of the beam 907. Further, these strain gauges 907A, 907B, 907C, 907D are used for form the Wheatstone bridge by respectively setting the strain gauges 907A, 907C, and those 907B, 907D to face each other as shown in Figure 8. In this case, E denotes a power supply terminal, G a ground terminal, and S1, S2 signal output terminals.

When acceleration is applied to the weight 901 in direction of arrow V in Figure 7, that is, in a direction perpendicular to the weight 901 (the direction in which the acceleration is detected), the weight 901 receives vertical force Fv, thus causing the beam to bend down in direction of arrow M as shown in Figure 9. As this time, tensile stress acts on the top

surface of the junction between the beam 907 and the support 906 and that of the junction between the beam 907 and the weight 901. As a result, the resistances of the strain gauges 907A, 907C formed in the lengthwise direction of the beam 907 increase, whereas those of the strain gauges 907B, 907D formed in the crosswise direction remain unchanged. Detection signals whose strength is proportional to the acceleration are thus output from the output terminals S1, S2 of the Wheatstone bridge.

As an ordinary diffusion technique is used for forming the strain gauges 907A, 907B, 907C, 907D, the surfaces of the weight 901, the beam 907 and the support 906 are covered with a passivation film 910 of SiO2, SiN or the like to protect them.

Since there exists a distance L from the strain centreline 909 of the beam 907 to the centre of gravity W of the weight 901 in the acceleration sensor of Figure 7, the distance L from the strain centreline 909 to the centre of gravity W of the weight 901, and the crosswise force Fh produced in the weight 901 due to acceleration causes a moment when the acceleration is applied to the weight 901 crosswise (the direction in which acceleration is non-detected) as shown in by an arrow H. Consequently, the beam 907 is caused to bend down in direction of arrow M as in a case where acceleration is applied vertically to the beam 907. In response to the strain, the Wheatstone bridge outputs a signal, which makes an interference output and lowers detection accuracy.

For the reason stated above, it may be considered remedial to reduce the distance L to zero by joining an additional weight 908 such as glass to the top surface of the weight 901 in order to make the centre of gravity

W of the combination of the weight 901 and the additional one 908 conform to the strain centreline 909 of the beam 907 (see Figures 12 and 13); however, the additional process step of joining them will increase the cost further.

Another problem arising from the aforementioned acceleration sensor is that detection sensitivity is low since the strain gauges formed in the top surface of the junction between the beam and the weight in the crosswise direction of the beam produce no resistance changes when acceleration is applied.

Moreover, the passivation film of SiO2, SiN or the like for the protection of the strain gauges is normally processed at high temperatures before being put back to the normal temperature. Notwithstanding, the difference in thermal expansion coefficient between the passivation film and the silicon semi-conductor may cause the bending of the beam 7 as shown in Figure 11 because of the stress generated on the surface of the silicon semi-conductor when the normal temperature is restored. The situation in which acceleration has been applied is brought about when the beam is caused to bend and voltage is output from the Wheatstone bridge likewise. This voltage is called an offset output and lowers not only the SN ratio of the sensor output but also detection accuracy.

It is an object of the invention to provide a semi-conductor acceleration sensor which can solve the above-mentioned problems, reduce the level of an interference output, and improve the working accuracy of the engraving process in the production. It is another object of the invention to provide a semi-conductor acceleration sensor which has an improved impact resistance and which is not required to be accommodated in a

hermetically sealed container that contains a damping liquid. Furthermore, another object of the present invention is to provide an acceleration sensor designed to improve detection sensitivity and to lower an interference output without the necessity of special process steps by solving the foregoing problems. And, furthermore, object of the present invention is to provide an acceleration sensor designed to lower offset voltage by means of passivation films.

According to the present invention there is provided a semi-conductor acceleration sensor including a weight having a rectangular thick-walled central portion and four rectangular thick-walled protrusions formed on the respective sides of the central portion, the sides thereof making a right angle with each other about the centre of the central portion, a thick-walled support having an inner rectangular opening set a predetermined space apart from the outer sides of the protrusions of the weight and formed in such a way as to surround the weight, four thin-walled beams coupling the protrusions to the support, the beams making a right angle with each other about the centre of the central portion of the weight, and strain gauges formed in the respective beams.

The strain gauges formed in the four beams of the semi-conductor acceleration sensor may include four strain gauges of a first type, these four strain gauges being formed in the top surfaces of the junctions between the beams and the support in the lengthwise direction of the beams respectively, and four strain gauges of a second type, these four strain gauges being formed in the top surfaces of the junctions between the beams and the weight in the lengthwise direction thereof respectively. A Wheatstone bridge may be set up by making two of the strain gauges out of the four strain gauges constituting the first type strain

gauge respectively face the remaining two strain gauges symmetrically about the centre point of the weight and by making two of the strain gauges out of the four strain gauges constituting the second type strain gauges respectively face the remaining two strain gauges symmetrically about the centre point of the weight. Passivation films may be provided on the surfaces of the respective beams with the strain gauges formed therein in the semi-conductor acceleration sensor in which the strain gauges to be formed in the four beams are respectively formed in the top surfaces of the junctions between the beams and the support in the lengthwise direction of the beams.

The sensor may be accommodated in a container which contains an inert gas.

The semi-conductor acceleration sensor is formed of a semi-conductor and includes a weight having a thick central portion and four thick protrusions formed on the respective sides of the central portion, the sides thereof making a right angle with each other about the centre of the central portion, a thick support having an inner opening set a predetermined space apart from the outer sides of the protrusions of the weight and formed in such a way as to surround the weight, four thin beams for coupling the one sides of the protrusions of the weight, the sides thereof making a right angle with each other about the centre of the central portion of the weight, and strain gauges formed in the respective beams, as the beams are formed along the respective sides of the central portion of the weight in this semi-conductor acceleration sensor, their lengthwise sides can be made longer and thereby the beams become readily bent.

The strain gauges formed in the four beams of the semi-conductor acceleration sensor include, four strain gauges on a first side, these four strain gauges being formed in the top surfaces of the junctions between the beams and the support in the lengthwise direction of the beams respectively, and four strain gauges on a second side, these four strain gauges being formed in the top surfaces of the junctions between the beams and the weight in the lengthwise direction thereof respectively. A Wheatstone bridge is set up by making two of the strain gauges out of the four strain gauges constituting the first side strain gauge respectively face the remaining two strain gauges symmetrically about the centre point of the weight and by making two of the strain gauges out of the four strain gauges constituting the second side strain gauges respectively face the remaining two strain gauges symmetrically about the centre point of the weight. When crosswise (the direction of non-detection) acceleration is applied, for instance, two pairs of strain gauges on the first and second sides which are symmetrical about the centre point of the weight give the following results: when compressive stress is applied to one of the strain gauges, tensile stress is applied to the other and no signals are output from the Wheatstone bridge as the resistance changes are mutually offset. When vertical (direction of detection) acceleration is applied, moreover, all the strain gauges on the first and second sides give the following results: when compressive stress is applied to one of the strain gauges, tensile stress is applied to the other and detection signals are output from the Wheatstone bridge as the resistances of all strain gauges change. Therefore, the interference output lowers, whereas detection sensitivity increases.

Furthermore, where passivation films are provided on the surfaces of the respective beams with the strain gauges formed therein, even though

stress is produced on the surface of the silicon semi-conductor because of the difference in thermal expansion coefficient between the passivation film and the silicon semi-conductor, the strain gauges in the top surfaces of the beams in the lengthwise direction produce the same resistance change and when they are connected to the Wheatstone bridge, the resistance changes are mutually offset with the effect of causing no offset output to be generated.

The semi-conductor acceleration sensor described above has a configuration by which the impact resistance of the sensor is improved, and can be accommodated in a hermetically sealed container which contains an inert gas instead of a conventional hermetically sealed container which contains a damping liquid.

The invention will further be described, by way of example, with reference to the accompanying drawings, in which:

Figures 1A and 1B show a conventional semi-conductor acceleration sensor;

Figure 2 is a sectional view of the sensor of Figure 1 housed within a hermetically sealed container containing a damping liquid;

Figure 3 is a sectional view showing the mechanism by which an interference output is generated in the sensor of Figure 1;

Figure 4 is a sectional view of another conventional semi-conductor acceleration sensor;

Figure 5 is a sectional view illustrating a method of processing a semi-conductor substrate used in the sensor of Figure 1 or Figure 4;

Figure 6 is a top view of another conventional semi-conductor acceleration sensor;

Figure 7 is a side view of the sensor of Figure 6;

Figure 8 is a connection diagram of the sensor of Figure 6;

Figures 9, 10 and 11 are side views illustrating the operation of the sensor of Figure 6;

Figure 12 is a top view of another conventional semi-conductor acceleration sensor;

Figure 13 is a side view of the sensor of Figure 12;

Figure 14A is a top view of another type of semi-conductor acceleration sensor;

Figure 14B is a sectional view along the line A-A of Figure 14A;

Figure 15 is a connection diagram of the sensor of Figure 14A;

Figures 16 and 17 are sectional views illustrating the operation of the sensor of Figure 14A;

Figure 18A is a top view of a semi-conductor acceleration sensor in accordance with an embodiment of the invention; and

Figure 18B is a sectional view along the line B-B of Figure 18A.

Figures 14A and 14B illustrate a semi-conductor acceleration sensor, Figure 14A being a top view and Figure 14B a sectional view taken on line A-A of Figure 14A. As shown in Figures 14A and 14B the semi-conductor acceleration sensor is formed of a semi-conductor and includes a rectangular thick weight 901 which is, for example, 400 μ thick, a thick support 906 having an inner square opening set a predetermined space apart from the weight 901 and formed in such a way as to surround the weight 901, four thin beams 902, 903, 904, 905 which are, for example, 20 ~ 40 μ thick, for coupling two opposed sides of the weight 901 to the respective opposed inner sides of the support 906, and strain gauges 902A, 902B, 903A, 903B, 904A, 904B, 905A, 905B formed in the respective beams 902, 903, 904, 905. The strain gauges 902A, 903A, 904A, 905A among all these gauges are formed in the top surfaces of the junctions between the support 906 and the beams 902, 903, 904, 905 with the gauges extending in the lengthwise direction of beams, respectively. On the other hand, the strain gauges 902B, 903B, 904B, 905B are formed in the top surfaces of the junctions between the weight 901 and the beams 902, 903, 904, 905 with the gauges in the lengthwise direction of the beams, respectively. Assuming that the strain gauges 902A, 903A, 904A, 905A formed in the top surfaces of the respective junctions between the beams and the support are called a first side strain gauge and the strain gauges 902B, 903B, 904B, 905B formed in the top surfaces of the respective junctions between the beams and the weight are called a second side strain

gauges, a Wheatstone bridge of Figure 15 can be set up by connecting the strain gauges 902A, 905A in an arm which opposes an arm containing the strain gauges 903A, 904A, and by connecting the strain gauges 902B, 905B in an arm which opposes an arm containing the strain gauges 903B, 904B. In this case, V denotes a power supply terminal, G a ground terminal, and S1, S2 signal output terminals.

When acceleration is applied to the weight 901 in direction of arrow V in Figure 14B that is, in a direction perpendicular to the weight 901 (the direction in which the acceleration is detected), the weight 901 receives vertical force Fv, moves downward as shown in Figure 16 and is supported by the beams 902, 903, 904, 905 on both sides. At this time, tensile stress acts on the top surfaces of the junctions between the beams and the support 906, whereas compressive stress acts on the top surfaces of the junctions between the beams and the weight 901. Then the resistances of the strain gauges 902A, 903A, 904A, 905A on the first side increase and the resistances of the strain gauges 902B, 903B, 904B, 905B on the second side decrease. Detection signals whose strength is proportional to the acceleration are output from the output terminals S1, S2 of the Wheatstone bridge accordingly.

When acceleration is subsequently applied to the weight 901 in direction of arrow H in Figure 14B that is, in the crosswise direction (the direction in which the acceleration is non-detected), a moment resulting from a distance L from the strain centreline 909 of the beam to the centre of gravity W of the weight 901 and the crosswise force Fh produced in the weight 901 because of the acceleration cause deformation as shown in Figure 17. With respect to the beams 902, 903, on the side pushed by weight 901, compressive stress acts on the top surface of the junction

between each beam and the support, and tensile stress acts on the top surface of the junction between each beam and the weight. With respect to the beams 904, 905 on the side pulled by the weight 901, tensile stress acts on the top surface of the junction between each beam and the support, and compressive stress acts on the top surface of the junction between each beam and the weight.

Therefore, the two pairs of strain gauges 902A, 905A and 903A, 904A which are symmetrical about the centre point C of the weight 901 among the four strain gauges 902A, 903A, 904A, 905A on the first side give the following results: the resistance of 902A decreases and that of 905A increases so that the resistance changes are offset; and the resistance of 903A decreases and that of 904A increases so that the resistance changes are also offset. This is also the case with the strain gauges 902B, 903B, 904B, 905B on the second side and the resistance changes are offset. In other words, no signal is output from the Wheatstone bridge.

Since the weight 901 of this semi-conductor acceleration sensor is supported by the beams 902, 903 and 904, 905 on both sides, the weight is supported by the beams on the left and right sides when acceleration is applied in the crosswise direction (the direction of non-detection). Therefore, the bending of the beams in this case is less than that of beams in a conventional case where the weight is supported by only those on one side. Moreover, the interference output is markedly decreased as the strain gauges mutually offset the resistance changes as previously noted.

When acceleration is applied in the vertical direction (the direction in which detection is made), signals are output from the Wheatstone bridge as the resistances of all strain gauges change. Consequently, the signal output increases.

Figures 18A and 18B illustrate a semi-conductor acceleration sensor which embodies the present invention: Figure 18A is a top view and Figure 18B is a sectional view taken on line B-B of Figure 18A. As shown in Figures 18A and 18B, the semi-conductor acceleration sensor is formed of a semi-conductor and includes a weight 901 having a square thick central portion 901 which is, for example, 400 μ thick and four rectangular thick protrusions 901A, 901B, 901C, 901D formed on the respective sides of the central portion 901, the sides thereof making a right angle with each other about the centre of the central portion 901, a thick support 906 having an inner square opening set a predetermined space apart from the outer sides of the protrusions 901A, 901B, 901C, 901D of the weight 901 and formed in such a way as to surround the weight 901, four thin beams 902, 903, 904, 905, which are, for example, 20 ~ 40 μ thick, for coupling the one sides of the protrusions 901A, 901B, 901C, 901D of the weight 901, the sides thereof making a right angle with each other about the centre of the central portion 901 of the weight 901, to the respective opposed inner sides of the support 906, and strain gauges 902A, 902B, 903A, 903B, 904A, 904B, 905A, 905B formed in the respective beams 902, 903, 904, 905. The strain gauges 902A, 903A, 904A, 905A among all these gauges are formed in the top surfaces of the junctions between the beams and the support in the lengthwise direction of the beams, respectively. On the other hand, the strain gauges 902B, 903A, 904B, 905B are formed in the top surfaces of the junctions between the beams and the weight in the lengthwise

direction of the beams, respectively. Like those shown in Figures 14A and 14B the strain gauges constitute the Wheatstone bridge likewise and operate in exactly the same way as in Figures 14A and 14B.

Since the beams 902, 903, 904, 905 are formed along the respective sides of the central portion 901A of the weight 901 in this semi-conductor acceleration sensor, their lengthwise sides can be made longer and thereby the beams become readily bent, thus improving detection sensitivity further.

In this case, the protrusions 901A, 901B, 901C, 901D provided on the respective sides of the weight 901 may be provided at one ends of the respective sides thereof in order to form each of the beams 902, 903, 904, 905 on one of two sides of the protrusion, the one side being spaced away more than the other side from the opposed inner side of the support 906. In this way, the length of the beams can be made greater.

In addition, passivation films 910 of SiO2, SiN or the like are formed to protect the strain gauges in the top surface of the semiconductor acceleration sensor shown in Figures 14A and 14B or that shown Figures 18A and 18B. The passivation film is normally formed at temperature of as high as hundreds of degrees and put back to the normal temperature. However, the difference in thermal expansion coefficient between the passivation film and the silicon semi-conductor causes stress to remain on the surface of the silicon semi-conductor. Although the resistances of the strain gauges 902A, 902B, 903A, 903B, 904A, 904B, 905A, 905B vary accordingly, the same resistance change is produced because all the strain gauges are provided in the longitudinal direction of the top surfaces of the beams. Since these strain gauges are entailing resistance

changes alike when they are connected to the Wheatstone bridge, these resistance changes are mutually offset and this prevents an offset output from being generated.

The semi-conductor acceleration sensor described above has a configuration by which the impact resistance of the sensor is improved, and can be accommodated in a hermetically sealed container which contains an inert gas instead of a conventional hermetically sealed container which contains a damping liquid, thereby improving the production yield.

In the semi-conductor acceleration sensor according to the present invention, the level of an interference output is reduced, the working accuracy of the engraving process in the production is improved, and the impact resistance is improved so that the sensor is not required to be accommodated in a hermetically sealed container which contains a damping liquid. According to the invention, therefore, a high-performance and low-cost semi-conductor acceleration sensor having an excellent detection accuracy and an improved production yield can be provided.

As the present invention is aimed to improve detection sensitivity and to lower the interference and offset outputs without the necessity of any additional process step by devising the configuration of the semi-conductor acceleration sensor formed of a semi-conductor, the number of the positions of the strain gauges, and the method of connecting them to be formed therein, it is possible to supply a high-performance semi-conductor acceleration sensor at low cost. A semi-conductor acceleration sensor of this sort is fit for various uses, to say nothing of

automotive use. The present invention adds a striking effect to supplying high-performance semi-conductor acceleration sensors at low cost.

CLAIMS

1. A semi-conductor acceleration sensor including a weight having a rectangular thick-walled central portion and four rectangular thick-walled protrusions formed on the respective sides of the central portion, the sides thereof making a right angle with each other about the centre of the central portion, a thick-walled support having an inner rectangular opening set a predetermined space apart from the outer sides of the protrusions of the weight and formed in such a way as to surround the weight, four thin-walled beams coupling the protrusions to the support, the beams making a right angle with each other about the centre of the central portion of the weight, and strain gauges formed in the respective beams.

2. A semi-conductor acceleration sensor as claimed in Claim 1, wherein said strain gauges formed in the four beams include four strain gauges on a first side, these four strain gauges being respectively formed in the top surfaces of the junctions between the beams and the support in the lengthwise direction of the beams, and four strain gauges on a second side, these four strain gauges being respectively formed in the top surfaces of the junctions between the beams and the weight in the lengthwise direction thereof and wherein a Wheatstone bridge is set up by making two of the strain gauges out of the four strain gauges constituting the first side strain gauge respectively face the remaining two strain gauges symmetrically about the centre point of the weight and by making two of the strain gauges out of the four strain gauges constituting the second side strain gauges respectively face the remaining two strain gauges symmetrically about the centre point of the weight.

3. A semi-conductor acceleration sensor as claimed in Claim 2, wherein passivation films are provided on the surfaces of the respective beams with the strain gauges formed therein.

4. A semi-conductor acceleration sensor as claimed in any one of Claims 1 to 3, wherein said sensor is accommodated in a container which contains an inert gas.

The Patent Office

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Claims searched: 1-4

Examiner: M. G. Clarke
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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): G1N NAFD4, NAGB4, NAGC4

Int Cl (Ed.6): G01P 15/12

Other: -------

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	US4641539	assigned to Texas Instruments Inc. - whole document	
A	US4553436	assigned to Texas Instruments Inc. - whole document	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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